PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY
(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION See Form PCT/IPEA/416	
71409-76546		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/SE 2004/001110	08-07-2004	14-07-2003
International Patent Classification (IPC) or national classification and IPC		
H04N 13/00, G06T 7/00		
Applicant		
CARLSSON, Stefan et al		

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 3 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. ☒ *(sent to the applicant and to the International Bureau)* a total of 8 sheets, as follows:
      ☐ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
      ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
   b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s))
      _____, containing a sequence listing and/or tables related thereto, in electronic form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).
4. This report contains indications relating to the following items:
   - ☒ Box No. I Basis of the report
   - ☐ Box No. II Priority
   - ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - ☐ Box No. IV Lack of unity of invention
   - ☒ Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - ☐ Box No. VI Certain documents cited
   - ☐ Box No. VII Certain defects in the international application
   - ☐ Box No. VIII Certain observations on the international application

Date of submission of the demand	Date of completion of this report
14-02-2005	14-09-2005
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INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/SE 2004/001110

Box No. I Basis of the report

1. With regard to the **language**, this report is based on:

☒ the international application in the language in which it was filed

☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of:

- ☐ international search (Rules 12.3(a) and 23.1(b))
- ☐ publication of the international application (Rule 12.4(a))
- ☐ international preliminary examination (Rules 55.2(a) and/or 55.3(a))

2. With regard to the **elements** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report):*

☐ the international application as originally filed/furnished

☒ the description:

pages 1-23 as originally filed/furnished
pages* _____ received by this Authority on _____
pages* _____ received by this Authority on _____

☒ the claims:

pages _____ as originally filed/furnished
pages* _____ as amended (together with any statement) under Article 19
pages* 1-8 received by this Authority on 07-09-2005
pages* _____ received by this Authority on _____

☒ the drawings:

pages 1-10 as originally filed/furnished
pages* _____ received by this Authority on _____
pages* _____ received by this Authority on _____

☐ a sequence listing and/or any related table(s) – see Supplemental Box Relating to Sequence Listing.

3. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages _____
- ☐ the claims, Nos. _____
- ☐ the drawings, sheets/figs _____
- ☐ the sequence listing *(specify)*: _____
- ☐ any table(s) related to the sequence listing *(specify)*: _____

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

- ☐ the description, pages _____
- ☐ the claims, Nos. _____
- ☐ the drawings, sheets/figs _____
- ☐ the sequence listing *(specify)*: _____
- ☐ any table(s) related to the sequence listing *(specify)*: _____

* *If item 4 applies, some or all of those sheets may be marked "superseded."*

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/SE 2004/001110

Box No. V **Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Claims	1-36	YES
	Claims		NO
Inventive step (IS)	Claims	1-36	YES
	Claims		NO
Industrial applicability (IA)	Claims	1-36	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

This report has been based on the amended claims filed with the letter of 07-09-2005.
Documents cited in the International Search Report:
D1: US5444478 A
D2: GB2354388 A
D3: WO03041411 A
D4: FR2696893 A
D5: US5187571 A
The cited documents represent the general state of the art.
The invention defined in claims 1-36 is not disclosed by any of these documents.
The cited prior art does not give any indication that would lead a person skilled in the art to the claimed method for generating a wide image video sequence, said method comprising the steps of: generating a set of calculated calibration parameters, related to a device having at least two video cameras which are arranged in a predetermined relationship to each other such that there will be an overlap between images from respective camera, said calculated calibration parameters being unique for the at least two cameras and their current location as related to the object being recorded; forming a synthetic image and identifying corresponding parts in overlapping parts of the image, and determining the relation between the respective coordinates for the pixels in the individual cameras and in the synthetic image; recording synchronously video sequences using each of said at least two video cameras; and generating a wide image video sequence from each of said synchronously recorded video sequences using said calculated calibration parameters.
Therefore, the claimed invention is not obvious to a person skilled in the art.
Accordingly, the invention defined in claims 1-36 is novel and is considered to involve an inventive step. The invention is industrially applicable.

Amended claims 05-09-01

1. A method for generating a wide image video sequence, said method comprising the steps of :

a. generating a set of calculated calibration parameters, related to a device having at least two video cameras which are arranged in a predetermined relationship to each other such that there will be an overlap between images from respective camera, said calculated calibration parameters being unique for the at least two cameras and their current location as related to the object being recorded;

b. forming a synthetic image and identifying corresponding parts in overlapping parts of the image, and determining the relation between the respective coordinates for the pixels in the individual cameras and in the synthetic image,

b. recording synchronously video sequences using each of said at least two video cameras, and

c. generating a wide image video sequence from each of said synchronously recorded video sequences using said calculated calibration parameters.

2. A method according to claim 1 in which the synchronously recorded video sequences are stored in a memory means.

3. A method according to claim 1 in which the synchronously recorded video sequences are used concurrently for generating the wide image video sequence.

4. A method according to claim 3 in which the wide image video sequence is transmitted live.

5. A method according to claim 3 in which the wide image video sequence is stored on a memory means.

6. A method according to claim 1 in which the generation of calibration parameters comprises the following steps:

a. Start of calibration process;

b. Synchronize the sequences from each camera, which means that at least a video sequence has to be recorded by all cameras;

c. Compute inter-image projective transformations;

d. Use the transformations to refer each image to a common reference frame;

e. Choose a real or virtual reference camera such that certain lines on the pitch and/or stadium are essentially horizontal and parallel in the wide image;

f. Select a rectangular region of interest within the wide image. This region contains e.g. the entire pitch and as much of the stadium as is required or visible; and

g. Record all computed values resulting from the calibration process to be used as the calibration parameters.

7. A method according to claim 6 in which the steps of finding the lens distortion parameter(s) for each camera, and correcting radial distortion in each image produced are comprised.

8. A method according to claim 6 in which the step of selecting non-linear distortion parameters to reduce perspective distortion of the wide image is comprised.

9. Method according to claim 1 in which step b is performed manually by identification of corresponding features in concurrent video images and the coordinates for these corresponding features are input to a computer means.

10. Method according to claim 1 in which step b is performed automatically by an algorithm for identification of corresponding features in concurrent video images and the coordinates for these corresponding features are input to a computer means.

11. Method according to claim 1 which comprises the following steps:

a. Apply the computed and registered calibration parameters.
For each pixel in the wide image, compute and store parameters describing
1. Which pixels from which image(s) contributes to this pixel in the wide image.
2. How much these pixels each contribute to the wide image;

b. Repeat until the end of the sequence is reached;

c. Obtain one new image from each camera;

d. If required, update the parameters needed to transform intensities (colours/brightness) in one or more cameras to eliminate visible seams;

e. If necessary, adjust the intensities (colours/brightness) in the images from one or more cameras;

f. Create the current seamless, wide image from the current images from each camera;

g. Output the wide image to a display or to a memory means; and

h. End of sequence. Return to step b until end of generation of the wide image video sequence.

12. Method according to claim 11 wherein the new images from each camera are read from live sources, each such source comprising a video camera.

13. Method according to claim 11 wherein the new images from each video camera are read from a memory means.

14. In a device having a processor means, which executes instructions stored in at least one memory means, a method for generating video sequences comprising the steps of:

a. generating a set of calculated calibration parameters, related to a device having at least two video cameras which are arranged in a predetermined relationship to each other such that there will be an overlap between images from respective camera, said calculated calibration parameters being unique for the at least two cameras and their current location as related to the object being recorded;

b. forming a synthetic image and identifying corresponding parts in overlapping parts of the image, and determining the relation between the respective coordinates for the pixels in the individual cameras and in the synthetic image,

b. recording synchronously video sequences using each of said at least two video cameras, and

c. generating a wide image video sequence from each of said synchronously recorded video sequences using said calculated calibration parameters.

15. In a device according to claim 14, the method in which the synchronously recorded video sequences are stored in a memory means.

16. In a device according to claim 14, the method in which the synchronously recorded video sequences are used concurrently for generating the wide image video sequence.

17. In a device according to claim 14, the method in which the generation of calibration parameters comprises the following steps:

a. Start of calibration process;

b. Synchronize the sequences from each camera, which means that at least a video sequence has to be recorded by all cameras;
c. Compute inter-image projective transformations;
d. Use the transformations to refer each image to a common reference frame;
e. Choose a real or virtual reference view such that certain lines on the pitch and/or stadium are essentially horizontal and parallel in the wide image;
f. Select a rectangular region of interest within the wide image. This region contains the entire pitch and as much of the stadium as is required or visible; and
g. Record all computed values resulting from the calibration process to be used as the calibration parameters.

18 In a device according to claim 14, the method in which the generation of calibration parameters the following steps of finding the lens distortion parameter(s) for each camera, and correcting radial distortion in each image produced are comprised.

19 In a device according to claim 14, the method in which the generation of calibration parameters the following step of selecting non-linear distortion parameters to reduce perspective distortion of the wide image is comprised.

20. In a device according to claim 14, the method in which step b is performed manually by identification of corresponding features in concurrent video images and the coordinates for these corresponding features are input to a computer means.

21. In a device according to claim 14, the method in which step b is performed automatically by an algorithm for identification of corresponding features in concurrent video images and the coordinates for these corresponding features are input to a computer means.

22. In a device according to claim 9, the method which comprises the following steps:
a. Apply the computed and registered calibration parameters.
For each pixel in the wide image, compute and store parameters describing
1. Which pixels from which image(s) contributes to this pixel in the wide image.
2. How much these pixels each contribute to the wide image;
b. Repeat until the end of the sequence is reached;

c. Obtain one new image from each camera;

d. If required, update the parameters needed to transform intensities (colours/brightness) in one or more cameras to eliminate visible seams;

e. If necessary, adjust the intensities (colours/brightness) in the images from one or more cameras;

f. Create the current seamless, wide image from the current images from each camera;

g. Output the wide image to a display or to a memory means; and

h. End of sequence. Return to step b until end of generation of the wide image video sequence.

23. In a device according to claim 22, the method wherein the new images from each camera are read from live sources, each such source comprising a video camera.

24. In a device according to claim 22, the method wherein the new images from each video camera are read from a memory means.

25. A computer readable memory means storing a program which executes the steps of:

a. generating a set of calculated calibration parameters, related to a device having at least two video cameras which are arranged in a predetermined relationship to each other such that there will be an overlap between images from respective camera, said calculated calibration parameters being unique for the at least two cameras and their current location as related to the object being recorded;

b. forming a synthetic image and identifying corresponding parts in overlapping parts of the image, and determining the relation between the respective coordinates for the pixels in the individual cameras and in the synthetic image,

b. recording synchronously video sequences using each of said at least two video cameras, and

c. generating a wide image video sequence from each of said synchronously recorded video sequences using said calculated calibration parameters.

26. A memory means storing a program according to claim 17, in which the synchronously recorded video sequences are stored in a memory means.

27. A memory means storing a program according to claim 17, in which the synchronously recorded video sequences are used concurrently for generating the wide image video sequence.

28. A memory means storing a program according to claim 17, in which the generation of calibration parameters comprises the following steps:

a. Start of calibration process;
b. Synchronize the sequences from each camera, which means that at least a video sequence has to be recorded by all cameras;
c. Compute inter-image projective transformations;
d. Use the transformations to refer each image to a common reference frame;
e. Choose a real or virtual reference view such that certain lines on the pitch and/or stadium are essentially horizontal and parallel in the wide image;
f. Select a rectangular region of interest within the wide image. This region contains the entire pitch and as much of the stadium as is required or visible; and
g. Record all computed values resulting from the calibration process to be used as the calibration parameters.

29. A memory means storing a program according to claim 28, in which the steps of finding the lens distortion parameter(s) for each camera, and correcting radial distortion in each image produced are comprised.

30. A memory means storing a program according to claim 28, the step of selecting non-linear distortion parameters to reduce perspective distortion of the wide image is comprised.

31. A memory means storing a program according to claim 28, in which step b is performed manually by identification of corresponding features in concurrent video images and the coordinates for these corresponding features are input to a computer means.

32. A memory means storing a program according to claim 28, in which step b is performed automatically by and algorithm for identification of corresponding features in

concurrent video images and the coordinates for these corresponding features are input to a computer means.

33. A memory means storing a program according to claim 28, which comprises the following steps:

a. Apply the computed and registered calibration parameters.
For each pixel in the wide image, compute and store parameters describing
1. Which pixels from which image(s) contributes to this pixel in the wide image.
2. How much these pixels each contribute to the wide image;

b. Repeat until the end of the sequence is reached;

c. Obtain one new image from each camera;

d. If required, update the parameters needed to transform intensities (colours/brightness) in one or more cameras to eliminate visible seams;

e. If necessary, adjust the intensities (colours/brightness) in the images from one or more cameras;

f. Create the current seamless, wide image from the current images from each camera;

g. Output the wide image to a display or to a memory means; and

h. End of sequence. Return to step b until end of generation of the wide image video sequence.

34. A memory means according to claim 28, wherein the new images from each camera are read from live sources, each such source comprising a video camera.

35. A memory means storing a program according to claim 28, wherein the new images from each video camera are read from a memory means.

36. A video recording apparatus for use in the method according to any of the claims 1 - 13 comprising:

a microprocessor(130), a memory means (120) for storing program for generating a set of calibration parameters related to a device having at least two video cameras which are arranged in a predetermined relationship to each other such that there will be an overlap between images from respective camera, said parameters being unique for the at least two cameras and their current location as related to the object being recorded;

said apparatus arranged to record synchronous video sequences using each of said at least two video cameras, and forming a synthetic image and identifying corresponding parts in overlapping parts of the image, and determining the relation between the respective coordinates for the pixels in the individual cameras and in the synthetic image,

said memory means (120) also storing program for recording of wide image video sequences;

read and write memory means (140) for storing data relating to recorded video sequences from at least two video cameras;

input means (300) for input of manual input of parameters, input of recorded video sequences, and output means (300) for output of a wide image video sequence.